Storage Behavior of Powdered Apple and Grape Juice Products[a]

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Data are presented on the flavor stability and extent of caking of powdered apple and grape juice products during storage for periods of up to one year at 73° F. and up to 6 months at 100° F., in 4-ounce cans. If moisture content when canned is low enough or is lowered sufficiently through inpackage desiccation after canning, both flavor retention and freedom from caking are quite satisfactory.

In previous papers *(3, 6)* the authors have described the preparation, using vacuum shelf drying, followed by grinding, of powdered apple and grape juice products. These powders, when reconstituted with water, yield beverages having pleasing natural color, flavor, and aroma similar to that of the original juices. Although the earlier papers described fully the technique of drying, grinding, and packaging these powders, they included only limited data on storage behavior. The present paper gives the results of a series of storage tests made on these powders.

PREPARATION OF POWDERS

Preparation of the powders followed the techniques given in the earlier papers *(3, 6)*. Blended concentrates of 75-80° Brix were charged to the vacuum shelf drier. These blends were prepared by thoroughly mixing together four ingredients, all liquids, in the following proportions:

Grape: 100 grams grape juice solids (as 75-80° Brix concentrate)
50 grams sucrose (as 80° Brix sirup)
1.4 grams tartaric acid[c] (as a solution containing 0.5 grams per ml.)
Sufficient 150-fold grape essence[d] (6.0 ml.) to give a ratio of essence to total solids corresponding to that of the original single strength grape juice from which the concentrate was prepared.

Apple: 100 grams apple juice solids (as 75-80° Brix concentrate)
100 grams sucrose (as 80° Brix sirup)
3.2 grams citric acid monohydrate (as a solution containing 0.85 grams per ml.)
Sufficient 150-fold apple essence (10.2 ml.) to give a ratio of essence to total solids corresponding to that of the fresh apple juice from which the concentrate was prepared.

The product, after vacuum shelf drying to about 2.5% moisture, was broken up into small pieces, blended, and ground in a small slow-speed hammer mill to produce a 10-mesh powder.

TEST PROCEDURE

The powder prepared as described, was packed into 4-ounce tin cans (size 202 x 214), and sealed either at atmospheric pressure, or under 27-inch vacuum, or in nitrogen after first evacuating to 27 inches and then breaking the vacuum with dry nitrogen. Each can contained about 95 g. of powder plus an envelope of tough paper[e,g] enclosing 9 g. of pelleted calcium oxide[f,g] as a desiccant.

Cans under test were stored in constant temperature rooms at 35° F., 73° F., and 100° F. Controls were kept at 0° F. At regular intervals during the test the products were evaluated for caking, sampled for moisture, reconstituted, and tasted. If tasting of a particular sample could not be done immediately, the powder was transferred to a sealed jar and held at 0° F. until tasted.

[a] Designation of the products described here has not as yet been made by the Food and Drug Administration. The terms used here are for purposes of description without implication of what labeling might be required in commercial use.

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[c] Tartaric acid was not used in making up the concentrate dried to powder for storage Test No. 1.

[d] Essence is an aqueous concentrate of the naturally-occurring volatile flavoring constituents obtained from the fresh juice, by a process developed at the E.U.R.B. *(1, 2)*.

[e] Promset 831-X made by Mid-States Gummed Paper Co.

[f] Desiccite 30 made by Filtrol Corp.

[g] Mention of this product does not imply recommendation by the USDA over similar products not mentioned.

TABLE 1

Taste panel ratings for storage tests Nos. 1 and 2, powdered grape juice product—no predesiccation used

Storage test No.	Type of pack	% Moisture as canned	Storage Temp., ° F.	Taste panel rating after storage period of (months)							
				1	2	3	4	5	6	7	12
1	Vac.[1]	3.2	0	Taken as "standard 8"							
	Air	3.2	100		7.6		6.6		5.9	5.5	
	Vac.	3.2	100		7.0		6.7		5.8	5.5	
	Air	3.2	73		7.9		7.8		7.7	7.7	7.5
	Vac.	3.2	73		7.9		7.9		7.7	7.7	7.5
2	Nit.[2]	3.0	0	Taken as "standard 8"							
	Air	3.0	100		6.2	6.2		6.4			5.8
	Nit.	3.0	100		6.7	6.6		6.5			5.8
	Air	3.0	73		7.9	8.0		7.4			7.7
	Nit.	3.0	73		7.9	8.0		7.5			7.7

[1] Vac. = 27" vacuum
[2] Nit. = nitrogen pack by exhausting to 27" vacuum then filling back to atmospheric pressure with nitrogen gas before sealing.

For taste evaluation the samples were reconstituted with water to a standard Brix; 12.5° for apple and 14.5° for grape. Tasting was done by a panel consisting of from 5 to 10 experienced tasters. These individuals were selected for their familiarity with the juices and for their consistency and acuity in tasting as measured by their ability to detect identical samples in a series of unknowns and the proximity of their rating to the panel average. In each taste test, two to four samples were compared with a control sample. Samples were rated using a scale of 5 to 9, with a rating of 8 assigned to the "standard" (control sample) and a rating of 6 denoting the "limit of acceptability." It is recognized that even a large panel, however skilled, cannot dependably predict the market acceptability of a product. The term acceptable used here means that the reconstituted product still possessed the characteristic fruit flavor as found in the control sample and had not developed to any marked degree "foreign" flavors not present in the control. In many of the taste tests a duplicate sample was included to check the tasters' accuracy. The scores of any tasters who did not assign identical ratings to the duplicates (within narrow limits) on any one test were not used in computing the average sample ratings for that test.

Color of the reconstituted juices was not specifically recorded, but it was noted that any serious change in color, such as browning of the grape, was accompanied by marked flavor deterioration. Caking of the powders was observed on emptying the cans and recorded by a descriptive term such as "in part loosely caked," "free flowing," "tightly caked," etc.

A small sample was taken as soon as the can was opened for moisture determination by the Karl Fischer method.

Three separate storage tests were made with the grape juice powder and one with the apple powder. All cans contained inpackaged desiccant. Test Nos. 1 and 2 were designed to show the effects of packaging the powdered grape product with air, nitrogen and vacuum without any in-the-can predesiccation period. In Test No. 3 various predesiccation conditions preceded storage of the grape product at 100° F. Predesiccation before storage at 100° F. was used in the test with the apple juice product.

RESULTS

It was found that both the apple and the grape juice products retain acceptable flavor for 6 months at 100° F. or for over a year at 73° F. and remain essentially free-flowing; provided that the moisture content of the powders is below certain limits.

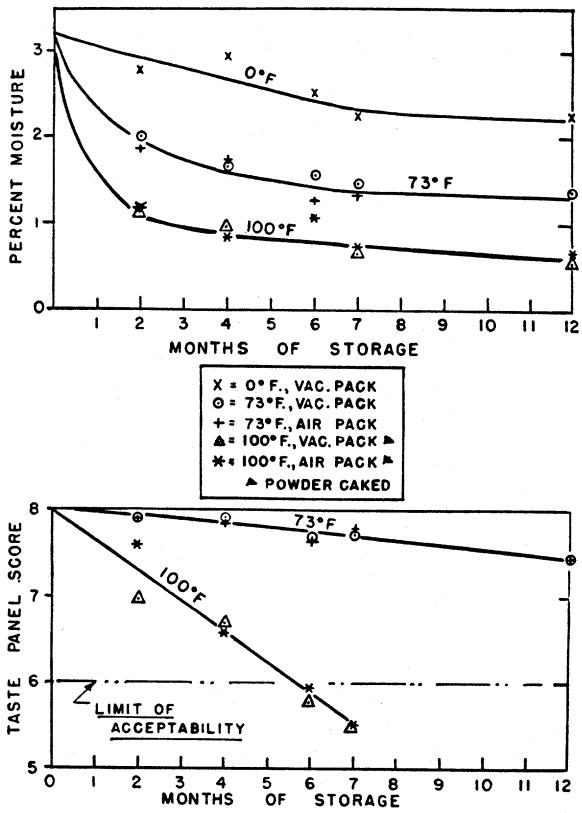


Figure 1. Storage Test No. 1, powdered grape juice product. Changes of moisture content and taste panel score with storage.

Apple and grape juice powders (with an inpackage desiccant) stored satisfactorily as regards caking and flavor at 73° F when their moisture contents as canned were 2.9% and 2.5% respectively. (The exact moisture contents above which caking at 73° F. becomes serious were not determined.) At 100° F. these same moisture levels were found satisfactory for flavor retention. However, at these moistures the products soon agglomerated into practically a single hard lump. To prevent such caking it was necessary to reduce the moisture by inpackage *pre*desicca-

TABLE 2

Taste panel ratings for storage test No. 3, powdered grape juice product,[1] using predesiccation

Predesiccation		Storage temp., ° F.	Taste panel ratings after storage for a period of (weeks)						
Time, wks.	Temp., ° F.		4	6	8	12	15	16	26
0	—	100		6.9			6.9		7.1
4	35	100		7.1			7.1		7.3
8	35	100		7.3			7.3		7.2
12	35	100		7.5			7.1		6.8
16	35	100		7.6			7.2		7.0
4	73	100		7.3			7.2		7.1
8	73	100		7.3			7.2		7.0
12	73	100		7.7			7.1		6.9
16	73	100		7.4			7.2		6.9
—	—	35	7.9		7.8	7.9		7.8	
—	—	73	7.7		7.6	7.7		7.5	7.6

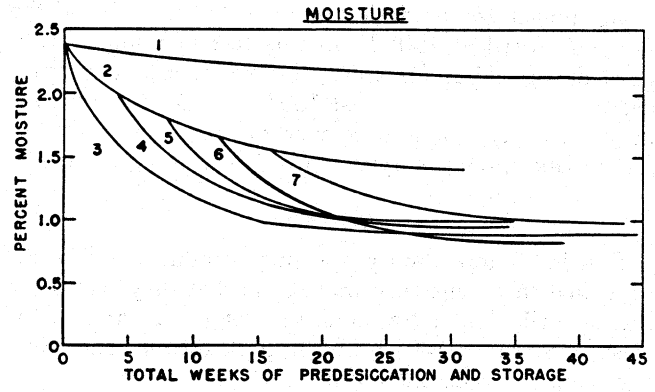
[1] Moisture content when canned was 2.4%; all cans packed at 27 inch vacuum. Control cans (Standard 8) stored at 0° F.

TABLE 3

Taste panel ratings for storage test No. 4, powdered apple juice product,[1] using predesiccation

Predesiccation		Storage temp., ° F.	Taste panel rating after storage for a period of (weeks)							
Time, wks.	Temp., ° F.		4	6	8	12	15	16	26	66
0	—	100		7.4			7.3		7.1	
4	73	100		7.4			7.2		7.3	
8	73	100		7.5			7.3		7.5	
12	73	100		7.3			7.2		7.1	
16	73	100		7.5			7.1		7.0	
—	—	73	7.6		7.7	7.6		7.6	7.6	7.7

[1] Moisture content when canned = 2.8%; all cans packed at 27 inch vacuum. Control cans (Standard 8) held at 0° F.



CURVE NO.	PREDESICCATION TIME AT 73°F., WKS.	STORAGE TEMP.,°F.
1	0	0
2	0	73
3	0	100*
4	4	100*
5	8	100*
6	12	100
7	16	100

*POWDER CAKED

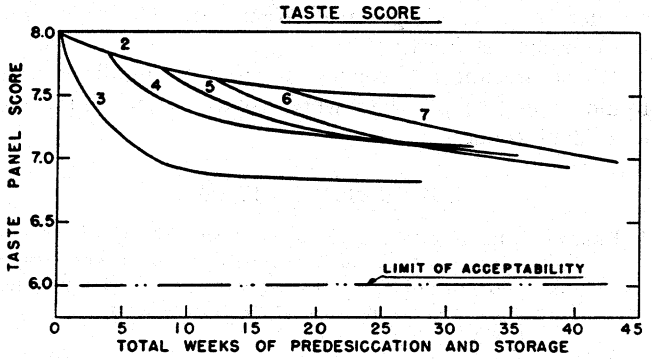


Figure 2. Storage Test No. 3, powdered grape juice product, using inpackage predesiccation at 73° F. Changes of moisture content and taste panel score with storage time.

tion to about 1.7% for the grape product and 2.0% for the apple product before placing them in 100° F. storage. Reduction in moisture to these levels, from the approximate 2.5% moisture attained in the drying step, was accomplished by storing the canned products for 12 weeks at 73° F. At the reduced moisture levels, such caking as did occur consisted only of a few lumps interspersed among the loose powder. These caused no problem on reconstitution.

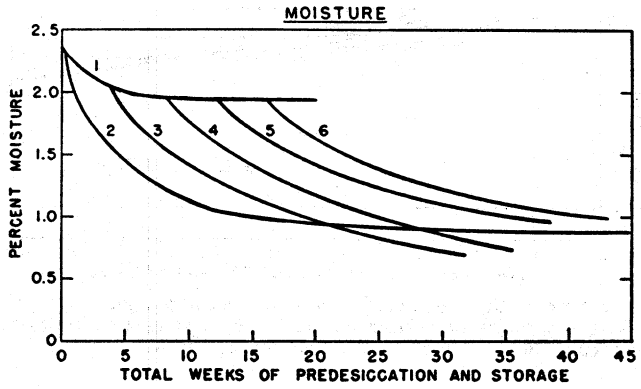
Direct attainment during the vacuum shelf drying operation of the low moisture levels required to forestall caking at 100° F. would have required a substantial increase in drying time over the normal 2½ hour cycle and would have resulted in appreciable heat damage to the flavor. Inpackage predesiccation in 4-ounce cans before storing at 100° F. is a practical method of attaining the very low moistures required *(4,5,7)*.

DISCUSSION

Tables 1, 2 and 3 give the taste panel results; Figures 1, 2, 3, and 4 present graphically both taste panel and moisture data. Except for Figure 1 the actual points have been omittted from the graphs to present a clearer, less cluttered picture. Figure 1 (Storage Test No. 1) presents moisture and taste data obtained in a typical storage test where inpackage predesiccation before storing at 100° F. was not used. Initial moisture content of the powder in this test (No. 1) was high and at 100° F. deterioration was rapid. Air and vacuum packs showed almost identical results. Caking was severe at 100° F. and significant at 73° F.

Storage Test No. 2, made to determine the effect of nitrogen pack, showed similar results in taste score to Test No. 1 (see Table 1). In both tests powder at 73° F. maintained a high score for 12 months. Packaging under nitrogen showed no improvement over atmospheric pack during one year at 73° F. At 100° F. nitrogen pack showed a slight initial superiority. Caking behavior in this storage test was the same as that in Storage Test No. 1.

Figures 2 and 3 show the results of Storage Test No. 3, powdered grape juice product, where inpackage predesiccation at 73° F. (Figure 2) and at 35° F. (Figure 3) was used before storing at 100° F. The inpackage predesiccation improved flavor stability during 100° F. storage, although even the non-predesiccated samples maintained appreciably better flavor at 100° F. than did the comparable samples in the earlier two storage tests. This latter fact is ascribed to the lower initial moisture content in Test No. 3. However, non-predesiccated samples stored at 100° F. in Test No. 3 were badly caked. Thus, predesiccation is necessary for 100° F. storage. In the samples stored at 73° F. and at 35° F. caking was negligible.



CURVE NO.	PREDESICCATION TIME AT 35°F., WKS.	STORAGE TEMP.,°F.
1	0	35
2	0	100*
3	4	100*
4	8	100*
5	12	100
6	16	100

*POWDER CAKED

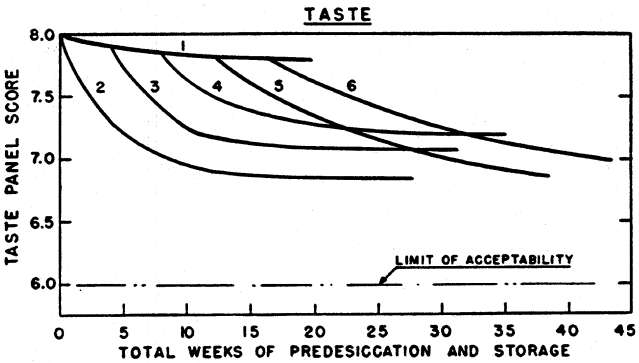
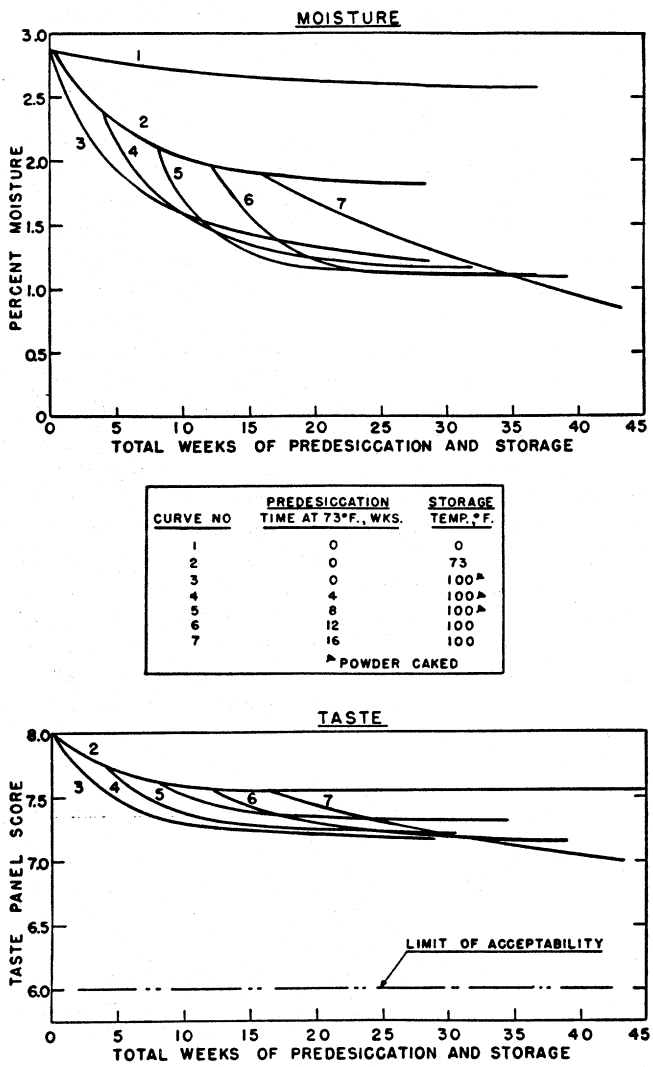


Figure 3. Storage Test No. 3, powdered grape juice product, using inpackage predesiccation at 35° F. Changes of moisture content and taste panel score with storage time.



CURVE NO	PREDESICCATION TIME AT 73°F., WKS.	STORAGE TEMP., °F.
1	0	0
2	0	73
3	0	100*
4	4	100*
5	8	100*
6	12	100
7	16	100

*POWDER CAKED

Figure 4. Storage Test No. 4, powdered apple juice product, using inpackage predesiccation at 73° F. Changes of moisture content and taste panel score with storage time.

From Figures 2 and 3 it can be seen that predesiccation at 73° F. proceeds much faster than at 35° F. Since the former is more economical and since the slightly higher flavor deterioration at 73° F. compared with 35° F. is soon offset at 100° F. storage, in-the-can predesiccation at 73° is preferable.

Figure 4 and Table 3 give moisture and taste results of Storage Test No. 4, powdered apple juice product, using inpackage predesiccation at 73° F. All of the samples stored at 100° F. in this test maintained very good flavor. Thus for apple, the use of inpackage predesiccation before storing at 100° F. is not required for flavor stability, but is necessary to prevent caking. At 73° F. caking of the apple powder was insignificant.

SUMMARY

Powdered apple and grape juice products have demonstrated in extensive storage tests that they will store satisfactorily for at least one year at 73° F. and for at least 6 months at 100° F., when packed in 4-ounce cans containing a desiccant envelope.

Moisture content of the powders is an important factor affecting their storage stability. For satisfactory storage at 73° F., moisture content when canned may be at least as high as 2.9% for the apple and 2.5% for the grape. (The exact upper limits were not determined.) For satisfactory storage at 100° F. without caking, moisture content when placed at 100° F. should be 2.0% or less for apple and 1.7% or less for grape. These lower moistures can be attained by storing the powders after canning for 12 weeks at 73° F. with an inpackaged desiccant.

No significant differences in storage stability were found when the powders were packed in air, nitrogen or under vacuum.

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